CHAPTER 4 - WATER USE AND QUALITY

INTRODUCTION

Water use and quality are key elements of understanding the relation of Coal Bed Methane (CBM) development and production to water resources. The type and magnitude of potential impacts due to the CBM development vary greatly throughout the CBM emphasis area and especially in the Montana portion of the Powder River Basin (PRB). In the Montana portion of the PRB, coal seam aquifers are relatively shallow and are relied on for a variety of uses, including industrial, irrigation, stock, public, and domestic. These uses can be influenced by the depth of the aquifers, water quality, and deliverability.

Although many coal seam aquifers in the Montana portion of the PRB are sufficiently shallow and of sufficient quality to attract usage, coal seams in other portions of the CBM emphasis area are much deeper and are not used to any significant extent. For instance, coals in Stillwater, Park, and Gallatin counties exist at depths up to 2,000 feet below ground surface (bgs) (Roberts and Rossi, 1999). In these areas, water supplies other than coal seam aquifers appear to adequately meet current and future anticipated demands.

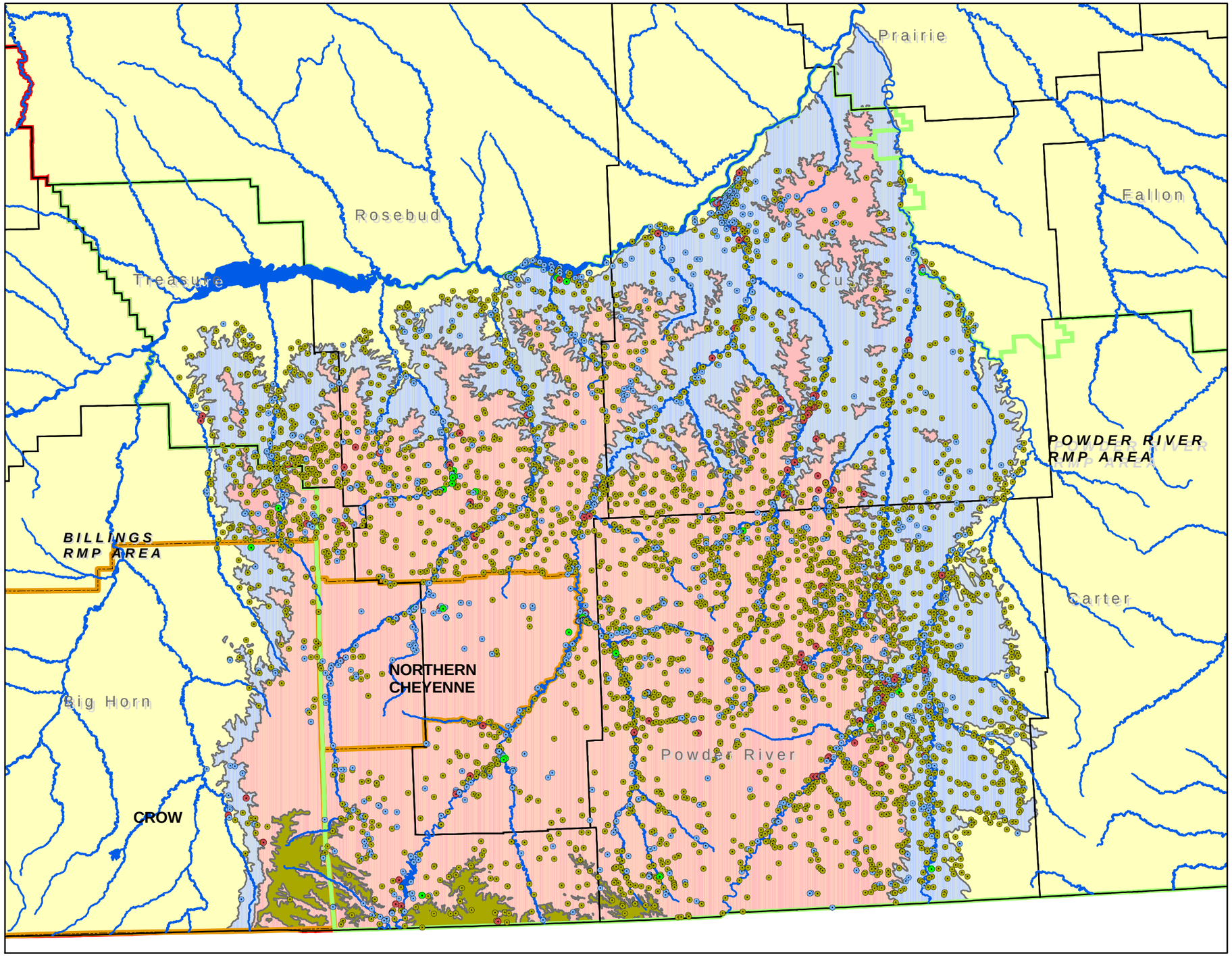
For the Montana portion of the PRB, groundwater usage can be visually represented using spatial analysis. Exhibit 20 shows a spatial representation of available water well types and locations throughout the boundaries of the PRB in Montana. This exhibit also shows outcrop geology, rivers, the Crow and Northern Cheyenne Indian Reservations, and boundaries of the Powder River and Billings Resource Management Planning (RMP) areas. Although important, water well information for the Crown and Northern Cheyenne Indians Reservations is believed to be somewhat incomplete. The true degree of incompleteness (i.e., how many wells are missing from this inventory) is unknown.

Further visual inspection of Exhibit 20 shows the majority of water supply wells in the Montana PRB are used for stockwater with smaller numbers of domestic use wells. There are also trends showing that many of the water wells in the study area fall along riverways, suggesting that source water for these wells is the alluvium aquifer and not coal seam aquifers. The largest density of wells primarily exists in the central portion of the basin along a path that generally stretches from southeast Treasure County to east-central Powder River County. Water supply wells are generally more sparsely scattered in the southwestern portion of the PRB in Montana, which include the area in the vicinity of the only commercially active CBM producing field in the state (i.e., CX Ranch).

In addition to water supply wells, natural springs play an important role with respect to water usage through the Montana portion of the PRB. Spring locations were not included in Exhibit 20 or another exhibit due to the lack of inventory data available for natural springs in the area. Therefore, it is important to also be aware of the fact that natural springs are yet another important water resources issue that could relate to CBM activities.

In addition to evaluation of groundwater use, surface water use is also a significant water resources issue throughout the CBM emphasis area and in the Montana portion of the PRB. Both groundwater and surface water usage varies widely by watershed with some areas having little water use with respect to water use applications, including industrial and agricultural use. In 1995, the United States Geological Survey (USGS) assessed surface water usage that included those watersheds in the PRB of Montana (USGS 1995).

Exhibit 20: Water Well Usage Map of the Montana Portion of the Powder River Basin



Legend

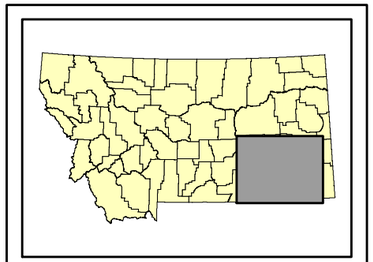
WELL USE

- DOMESTIC
- IRRIGATION
- PUBLIC WATER SUPPLY
- STOCKWATER

- Rivers
- Powder River RMP Area
- Billings RMP Area
- Native American Reservations

GEOLOGY

- Wasatch Fm.
- Tongue River Mbr.
- Lebo / Tullock Mbrs.



Location Map

Date Prepared: April 2, 2001

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Project Mgr.: D. Arthur

N W E S

1:880,000

20 10 0 20 Miles

20,000 10,000 0 20,000 40,000 Meters

DATA SOURCES

Counties: 1:100,000 scale, counties, Montana State Library/NRIS, Helena, Montana
Rivers: 1:100,000 scale, rivers, Montana State Library/NRIS, Helena, Montana
Reservations: 1:100,000 scale, reservations, Montana State Library/NRIS, Helena, Montana
RMP Areas: BLM State Office.
Geology: 1:250,000 scale, 1999, USGS Professional Paper 1625a.
Water Well Locations: Montana Bureau of Mines and Geology Water Well Database.

Exhibit 21 summarizes surface water withdrawal rates for the various watersheds of the Montana PRB from the above referenced USGS study. Withdrawal rates vary by watershed from approximately 37 cubic feet per second (cfs) in the Middle Powder watershed to nearly 1,000 cfs Little Big Horn watershed.

EXHIBIT 21 - WATER WITHDRAWAL RATES BY WATERSHED, MONTANA PRB
Summary of USGS data for surface water withdrawal rates for the various watersheds in the Montana portion of the PRB.

WATERSHED	AVERAGE SURFACE WATER WITHDRAWAL RATE IN 1994 (USGS, 1995)
Little Big Horn	975 cfs
Mizpah	640 cfs
Middle Powder	37 cfs
Rosebud	43 cfs
Upper Tongue	276 cfs
Lower Tongue	460 cfs

WATER QUALITY

Exhibit 22 shows select groundwater quality data collected from water supply wells located throughout the Montana portion of the PRB by source aquifer. Total dissolved solids (TDS) and Sodium Adsorption Ration (SAR) were selected to provide a generalized characterization of groundwater in the area. Data analysis shows water to be of poor to moderate quality with TDS concentrations that range throughout the study area from a county-average low of approximately 890 mg/L to a county-average high of nearly 2,500 mg/L. Similarly, SAR ranges from a county-average low of approximately 5 to a county-average high of approximately 64. Water quality in the Fort Union Formation, which contains all of the potential CBM producing horizons, has a basin-wide average TDS and SAR of approximately 1,892 mg/L and 18, respectively

EXHIBIT 22 - GROUNDWATER QUALITY FOR THE MONTANA PORTION OF THE POWDER RIVER BASIN
Selected groundwater quality data collected from water supply wells located throughout Montana PRB

	JUDITH RIVER FORMATION		HELL CREEK /FOX HILLS FORMATION		FORT UNION FORMATION		QUATERNARY ALLUVIUM	
County	Avg. TDS (mg/L)	Avg. SAR	Avg. TDS (mg/L)	Avg. SAR	Avg. TDS (mg/L)	Avg. SAR	Avg. TDS (mg/L)	Avg. SAR
Big Horn	936	54	1440	14	1658	8	2118	5
Rosebud	2465	31	1376	35	1595	16	1516	9
Powder River	No data	No data	890	35	1882	15	2783	5
Custer	No data	No data	896	37	1810	31	1665	8
Treasure	2312	64	1985	56	1782	32	2437	10
Weighted Average	2100	42	1148	37	1892	18	2014	7

Note: Avg. TDS = Average Total Dissolved Solids, Avg. SAR = Average Sodium Adsorption Ratio

Groundwater quality for the Montana PRB can be further analyzed through review of monitoring data near coal mining areas. Exhibit 23 presents a summary of groundwater quality statistics for various coal seam aquifers. This exhibit shows that average TDS varies from approximately 900 mg/L (Pearl Mine) to approximately 2,800 mg/L (Decker Mine). Similarly, average SAR values vary from approximately 2 to 100. Water from the Big Sky mine,

located approximately 50 miles north of Decker, near Colstrip, Montana, appears to be much less saline than coal aquifer water in the vicinity of the Decker mine. Groundwater from the Carbone area, on the north edge of the Spring Creek mine and just north of the CX Ranch field, has SAR values exceeding 100 – which are very high for the Montana portion of the PRB. Groundwater from the Rosebud mine, near Colstrip, Montana, also appears to be less saline than other coal mining areas.

EXHIBIT 23 - SUMMARY GROUNDWATER STATISTICS OF COAL AQUIFERS FROM COAL MINES IN THE PRB

Summary of groundwater quality statistics for various coal seam aquifers in the Montana portion of the PRB.

COAL MINE AREA	AQUIFER	TOTAL DISSOLVED SOLIDS MG/L (samples)	SAR (samples)
Pearl Mine, Big Horn County (Hedges, Van Voast, and McDermott, 1976)	Alluvium	1516 (4)	1.6 (4)
	G – Coal	401 (2)	34 (2)
	M – Coal	1086 (11)	22 (11)
	O – Coal	1249 (3)	41 (3)
	Coal average	**912**	**32**
Big Sky Mine – Area B Rosebud County (MDSL, 1988)	Alluvium	1762 (64)	1.5 (64)
	Overburden	1276 (53)	1.3 (53)
	Rosebud Coal	2324 (63)	5 (63)
	McKay Coal	2376 (66)	9.5 (66)
	Sub-McKay Coal	2343 (98)	7 (98)
	Coal average	**2348**	**7**
Carbone Amendment Area Big Horn County (BLM, 2000c)	Alluvium	827 (35)	9.6 (35)
	Overburden	1578 (10)	211 (10)
	Anderson	1185 (70)	74 (70)
	Canyon	1070 (2)	129 (2)
	Coal average	**1128**	**101**
Rosebud Mine, Rosebud County (MDEQ, Appendix B)	Alluvium	2647 (610)	1.8 (778)
	Rosebud Coal	1311 (446)	1.3 (520)
	McKay Coal	1800 (482)	2.04 (582)
	Sub-McKay Coal	1654 (166)	6.06 (229)
	Coal average	**1578**	**2.44**
Decker Mine, Big Horn County (MDEQ, Appendix C)	Alluvium	3,420-4,340 (42)	0.3-8 (42)
	Anderson	502-3,400 (82)	8-77 (82)
	Dietz	430-6,520 (261)	1-131 (261)
	Canyon	1,060-2,860 (54)	14-72 (54)
	Coal Average	**2,816**	**38.91**

Additional groundwater quality data is available from samples collected from CBM production at the CX Ranch field near Decker, Montana. Exhibit 24 presents detailed analytical data from water collected as part of CBM production operations. Both TDS concentrations and SAR values align with water quality data obtained from other sources with TDS concentrations ranging from approximately 1,400 to 1,580. SAR values ranged from approximately 33 to 47. Several other water quality parameters are shown in Exhibit 24. This data shows that fluoride, aluminum, lead and barium have exceeded federal drinking water standards. Water from these Fort Union coals seam aquifers also exceeds livestock watering guidelines for aluminum and fluoride.

EXHIBIT 24 - DETAILED PRODUCED WATER QUALITY FROM THE CX RANCH CBM FIELD

Results of CX Ranch CBM production water compared to National and State standards and various other coal seam water analytical data.

ANALYTE	NATIONAL DRINKING WATER STANDARDS (primary unless noted)	MT. WATER QUALITY STDS. FOR LIVESTOCK PPM (MSU 2001)	CX RANCH AVERAGE (MDEQ, 2000)	DIETZ COAL WATER SW-SW SEC 20-9S-40E (Williams, 2001)	MONARCH COAL WATER SW-SW SEC 20-9S-40E (Williams, 2001)	CARNEY COAL WATER SW-SW SEC 20-9S-40E (Williams, 2001)
TDS mg/L	500 (secondary)	10,000	1,400	1,580	1,460	1,420
SAR			47	42.3	46.6	33.3
Sodium mg/L			558	603	567	547
Ammonia, Total mg/L			2.0			
Ammonia, nitrogen mg/L				2.42	2.35	2.10
Bicarbonate as HCO3 mg/L				0.0	1,600	1,550
Chloride mg/L	250 (secondary)		19	19.9	19.7	19
Fluoride mg/L	2.0 (secondary)	2	2.5	1.43	2.68	3.66
Phosphorous, total mg/L				0.120	90	800
Sulfate mg/L	250 (secondary)			<0.01	<0.01	<0.01
Aluminum, total mg/L	0.05 to 0.2 (secondary)	5	0.05	<0.050	1.38	44.7
Arsenic mg/L	0.05	0.2	0.001	<0.001	<0.001	0.028
Barium mg/L	2.0		0.5	0.5	0.6	2.2
Beryllium mg/L	0.004		0.0005			
Boron mg/L		5	0.07	0.05	0.08	0.10
Cadmium mg/L	0.005	0.05		<0.0002	<0.0002	0.0015
Chromium mg/L	0.1	1		<0.001	0.002	0.064
Calcium mg/L				9.4	7.5	10.9
Copper mg/L	1.0 (secondary)	0.5	0.001	0.103	0.013	0.112
Lead mg/L	0.015	0.05	0.002		0.005	0.136
Iron, dissolved mg/L	0.3		0.03			
Iron, total mg/L			0.125	0.310	1.4	23.0
Magnesium mg/L				3.6	2.3	5.8
Manganese mg/L	0.05		0.01	<0.01	0.020	
Mercury mg/L	0.002	0.1		<0.00006	<0.00006	<0.00006
Molybdenum mg/L				<0.02	<.02	<0.020
Nickel mg/l				<0.01	<0.01	0.060
Potassium mg/L				6.1	6.5	8.8
Selenium mg/L	0.05	0.5		<0.005	<0.005	0.007
Strontium mg/L			0.43			
Radium mg/L	5 pCi/L		0.2			
Vanadium mg/L		0.1		<0.02	<0.02	0.090
Zinc mg/L	5 (secondary)	24		0.03	0.02	0.290